Figure 12 gives the normalized version of Figure 11, while **Figure 13** displays the CLIO horizontal polar plot (in 10° increments). And finally, **Figure 14** gives the two-sample SPL comparisons, showing a close match (less than 0.5 dB) throughout the operating range.

For the remaining series of tests on the Faital Pro 6RS140, I employed the Listen, Inc. SoundCheck AudioConnect analyzer and SCM microphone (graciously supplied to *Voice Coil* by the folks at Listen, Inc.) to measure distortion and generate time-frequency plots. For the distortion measurement, I mounted the 6RS140 rigidly in free-air, and set the SPL to 104 dB at 1 m (12.5 V) using a pink noise stimulus. I measured the distortion with the Listen microphone placed 10 cm from the driver. This produced the distortion curves shown in **Figure 15**.

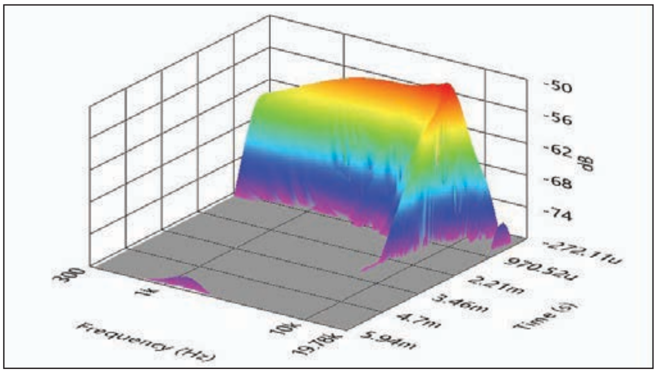

Figure 17: Faital Pro 6RS140 woofer SoundCheck Wigner-Ville plot

Next, I employed the SoundCheck software (Version 17) to get a 2.83 V/1 m impulse response and imported the data into Listen's SoundMap Time/Frequency software. **Figure 16** shows the resulting cumulative spectral decay (CSD) waterfall plot. **Figure 17** shows the Wigner-Ville plot (used for its better low-frequency performance).

Examining the various data I collected for the 6RS140, even without doing any kind of subjective evaluation, it looks like a very well-crafted product. The driver readily portrays the kind of engineering integrity and high build quality you would expect from Faital Pro. For more information, visit www.faitalpro.com.

The W8-2314

The second driver I characterized this month came from Tang Band (TB) Speaker Co., Inc., a company I have known for many years and one that often produces unique and creative transducer designs. This month's sample is no exception. Coaxial drivers for home audio applications have been a staple in the industry for a number of years, especially designs that are similar to the KEF Uni-Q/Tannoy Duo-Concentric products where the tweeter is located at the location normally reserved for a dust cap.

The subject of this explication is a new coaxial design in that vein recently released by TB Speaker, the W8-2314 (see **Photos 2-4**). In terms of features, the W8-2314 is built on an eight-spoke two-part ABS injection-molded frame that incorporates a separate injection-molded trim ring. Cooling for this driver is provided primarily via the completely open area below the spider (damper) mounting shelf. Incorporated into the frame is the underhung-type woofer motor that consists of a circular array of six neodymium slugs—an arrangement that makes room for the concentrically mounted 25 mm tweeter and tweeter rear cavity.

This multi-neodymium magnet underhung motor drives a 44.43 mm diameter voice coil wound with round copper wire on an conducting aluminum former glued to a moderately curvilinear bamboo fiber paper cone. Compliance for this driver is rather unique. The NBR/CBR surround has a primarily flat profile articulated with a series of oval reliefs on its surface. The spider is also unconventional and consists of a 3.5" diameter NBR/CBR flat profile with no waves, so more like a small flat surround. All this is terminated to gold terminals located on opposite sides of the frame to discourage rocking modes.

The tweeter dome is a 25 mm aluminum/magnesium alloy inverted type suspended with a black NBR/CBR surround that has similar oval reliefs around its perimeter. This high-frequency device incorporates a neodymium slug with a low resonance rear cavity as well as a copper-colored decorative protective grill with gold plated terminals located between the two woofer terminals. With all of this taken together, I would have to say that TB Speaker's W8-2314 coaxial is as unique a design as I have encountered in quite some time.

Photo 2: Tang Band (TB) Speaker's W8-2314

Photo 3: Close-up shot of the tweeter for TB Speaker's W8-2314

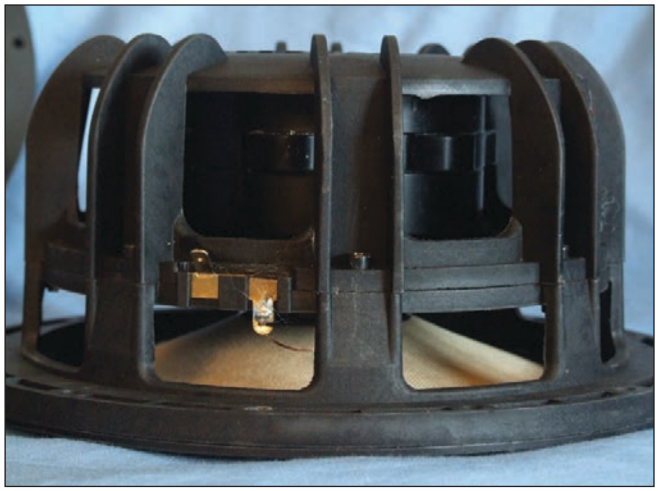

Photo 4: Close-up shot of the woofer for TB Speaker's W8-2314

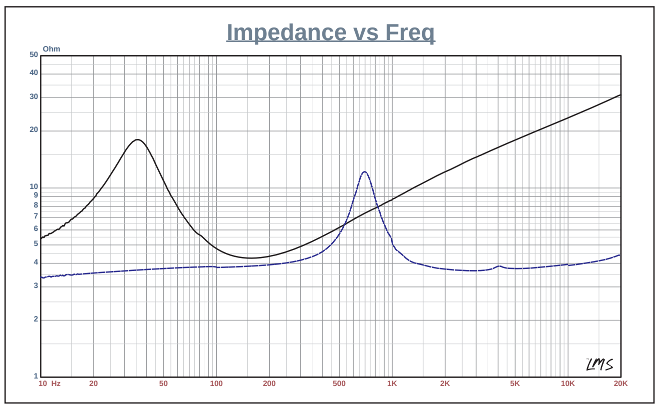

Figure 18: TB Speaker W8-2314 free-air impedance plot (solid black curve = woofer, dashed blue curve = tweeter dome)

	TSL Model		LTD Model		Factory
	Sample 1	Sample 2	Sample 1	Sample 2	
F_S	34.3 Hz	34.7 Hz	33.8 Hz	32.0 Hz	38 Hz
R_{EVC}	3.64	3.63	3.64	3.63	3.6
Sd cm^2	191.1	191.1	191.1	191.1	131.0
Q_{MS}	1.82	1.77	1.85	1.61	2.14
Q_{ES}	0.47	0.45	0.49	0.43	0.37
Q_{TS}	0.37	0.36	0.39	0.34	0.31
V_{AS}	48.8 ltr	47.8 ltr	51.7 ltr	57.7 ltr	51.3 ltr
SPL 2.83 V	88.1 dB	88.4 dB	87.8 dB	88.1 dB	90 dB/1 W1 m
X_{MAX}	6 mm	6 mm	6 mm	6 mm	6 mm

Table 2: Comparison test data for TB Speaker's W8-2314 coaxial driver

Testing began with the woofer half of this coaxial driver. I used the LinearX LMS and VIBox to produce both voltage and admittance (current) curves with the driver clamped to a rigid test fixture in free-air at 0.3 V, 1 V, 3 V, 6 V, 10 V, 15 V, and 20 V. Note that the LMS oscillator is turned on for a progressively increasing time period between sweeps in order to keep the driver heated as close to the third thermal time constant as possible (from 10-30 seconds between sweeps, depending on the voltage level). LEAP 5 was unable to curve fit the 15 V and 20 V curves, so these were discarded.

Next, I post-processed the 10 550-point stepped since wave sweeps for each sample and divided the voltage curves by the current curves to derive impedance curves, phase calculated. I imported the data, along with the accompanying voltage curves, to the LEAP 5 Enclosure Shop software. I additionally created a LEAP 4 TSL model using the 1 V free-air curves. I selected the complete data set, the multiple voltage impedance curves for the LTD model, and the 1 V impedance curves for the TSL model in LEAP 5's transducer derivation menu and created the parameters for the computer box simulations. **Figure 18** shows the woofer's 1 V free-air impedance curve (solid black curve) and the tweeter's impedance curve (dashed blue curve). **Table 2** compares the LEAP 5 LTD and TSL data and factory parameters for both W8-2314 samples.

Parameter measurement results for the W8-2314 were reasonably close to the factory data except for some minor deviation in the sensitivity due to different criteria (2.83 V vs. 1 W/1 m). Since everything looked good, I proceeded to set up two computer enclosure simulations using the LEAP LTD parameters for Sample 1. This produced enclosure simulations—a 0.68 ft^3 Butterworth (Qtc = 0.7) sealed box alignment with 50% fiberglass fill material, and a 1.13 ft^3 QB3 vented box alignment with 15% fiberglass fill material.

Figure 19 displays the results for the W8-2314 woofer in the sealed and vented simulated enclosures at 2.83 V and at a voltage level sufficiently high enough to increase cone excursion to Xmax + 15% (6.9 mm for the W8-2314). This produced a F3 frequency of 69 Hz (-6 dB = 62 Hz) for the sealed box with a Qtc = 0.77, and a –3 dB = 47 Hz (-6 dB = 39 Hz) for the vented enclosure. Maximum linear excursion (Xmax + 15%) resulted in 109 dB at 23 V for the closed box enclosure simulation and 111 dB at 27 V input for the vented simulation. **Figure 20** shows the 2.83 V group delay curves and **Figure 21** shows the 23 V/27 V excursion curves.

Klippel analysis for the W8-2314 woofer produced the Bl(X), Kms(X) and Bl and Kms symmetry range plots

Figure 19: TB Speaker W8-2314 woofer computer box simulations (black solid = sealed at 2.83 V; blue dash = vented at 2.83 V; black solid = sealed at 23 V; blue dash = vented at 27 V)

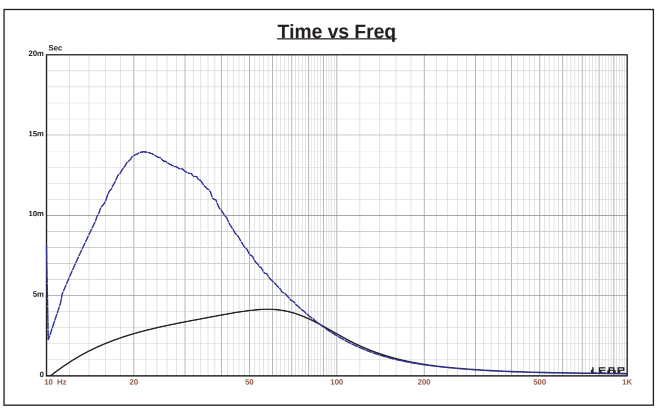

Figure 20: Group delay curves for the 2.83 V curves in Figure 19

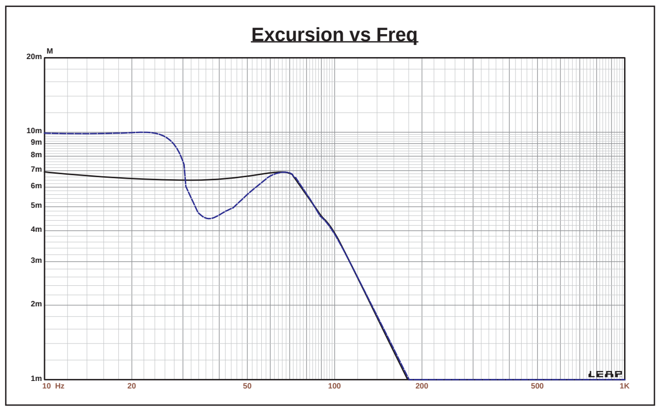

Figure 21: Cone excursion curves for the 30 V curves in Figure 19

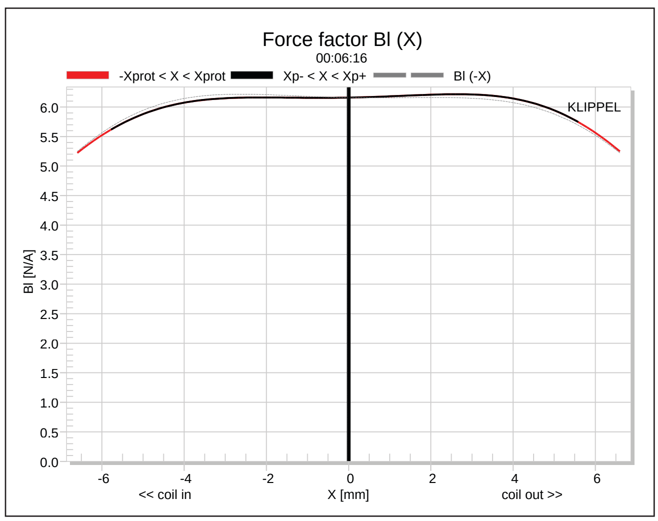

Figure 22: Klippel analyzer Bl(X) curve for the TB Speaker W8-2314

shown in **Figures 22-25**. The Bl(X) curve for the W8-2314 woofer (Figure 22) is rather broad and symmetrical, with a degree of coil-out offset. Looking at the Bl symmetry plot (Figure 23), the displacement resolves to near zero (0.05 mm) at the 6 mm physical Xmax position.

Figure 24 and **Figure 25** show the Kms(X) and Kms symmetry range curves for the W-2314 woofer. The Kms(X) curve is also fairly symmetrical in both directions, as well as having relatively amount of coil-in offset. Looking at the Kms symmetry range plot (Figure 25), the offset resolves to 0.28 mm at the physical 6 mm Xmax position.

Displacement limiting numbers calculated by the Klippel analyzer fwere XBl at 82% Bl >5.6 mm and for XC at 75% Cms minimum was 1.9 mm, which means that for this home audio 8" woofer, the compliance is the most limiting factor for the prescribed distortion level of 10%.

While the 1.9 mm for XC seems really low, if you look at the multi-voltage impedance curves taken in free-air you can see that as voltage increases, the W8-2314's resonance climbs rather quickly above 10 V. Given the ear's lack of sensitivity to low-frequency distortion, this driver likely sounds fine at nominal SPL levels, but may suffer at really high SPL above 95 dB to 100 dB. **Figure 26** shows the impedance curves. This a really interesting driver, so I don't think that is a negative, I would just suggest that

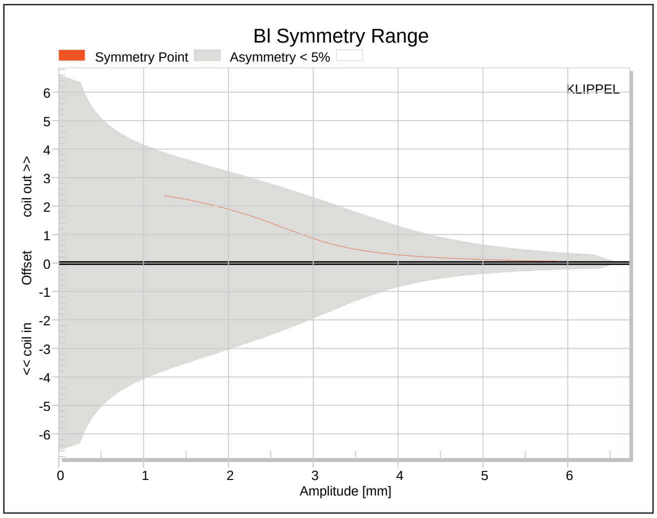

Figure 23: Klippel analyzer Bl symmetry range curve for the TB Speaker W8-2314

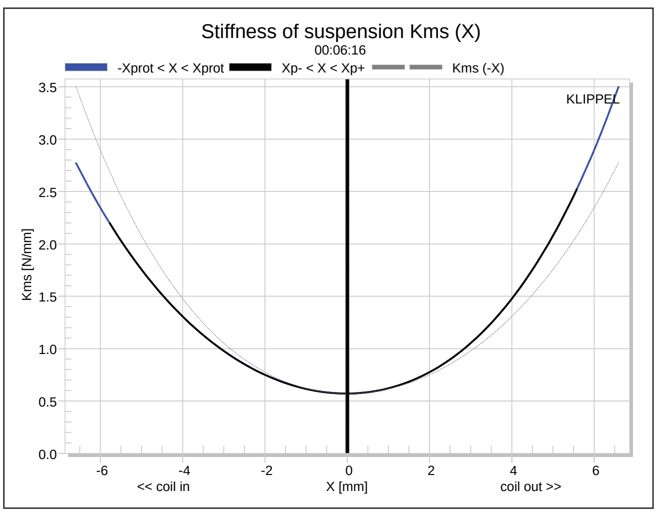

Figure 24: Klippel analyzer mechanical stiffness of suspension Kms(X) curve for the TB Speaker W8-2314

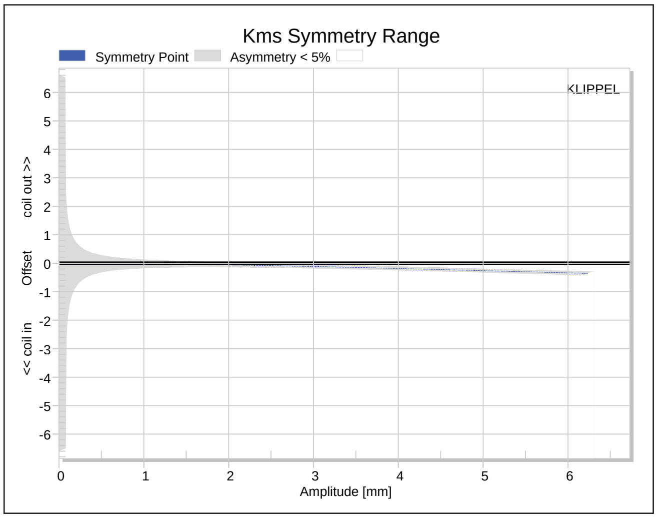

Figure 25: Klippel analyzer Kms symmetry range curve for the TB Speaker W8-2314

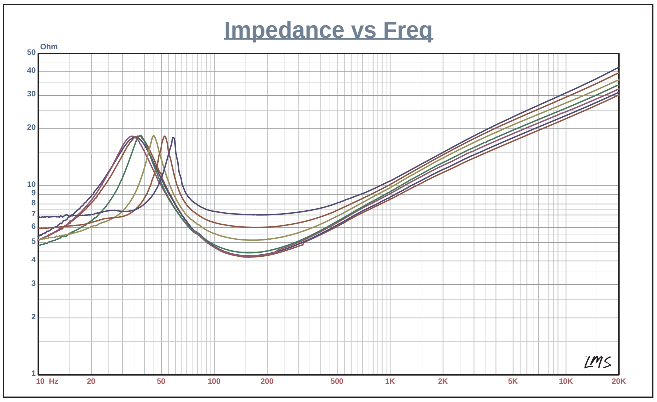

Figure 26: TB Speaker W8-2314 impedance curves at 0.3 V to 20 V

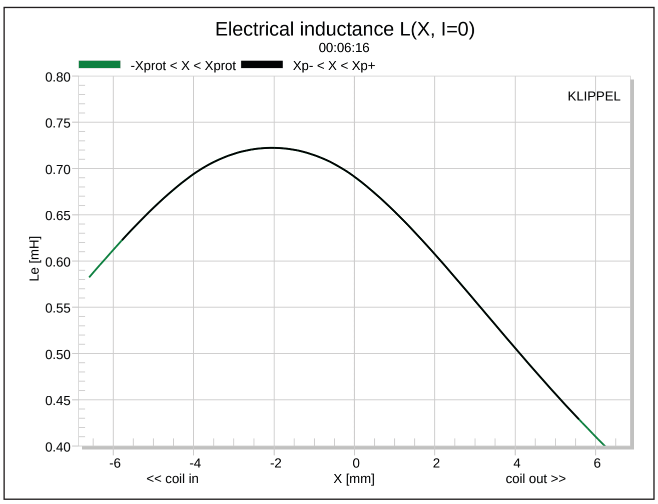

Figure 27: Klippel analyzer L(X) curve for the TB Speaker W8-2314

Figure 28: TB Speaker W8-2314 woofer on-axis frequency response

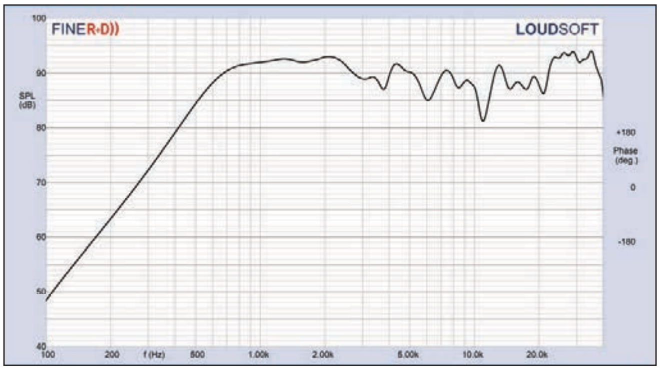

Figure 29: TB Speaker W8-2314 tweeter on-axis frequency response

for higher SPL applications, the driver be high-passed at 100 Hz and incorporated with a 8″ to 10″ subwoofer. And the last Klippel graph, **Figure 27**, shows the W8-2314's inductance curve L(X). The inductance swing from 0 mm to Xmax in and out is a maximum of 0.27 mH, so reasonably controlled.

That said, I proceeded to mount the W8-2314 in an enclosure, which had a 16″ × 9″ baffle, filled with foam damping material. I then measured both the woofer and the tweeter's on- and off-axis frequency response from 200 Hz to 40 kHz normalized to 2.83 V/1 m using the LOUDSOFT FINE R+D analyzer and the GRAS 46BE microphone using the cosine windowed FFT method. All

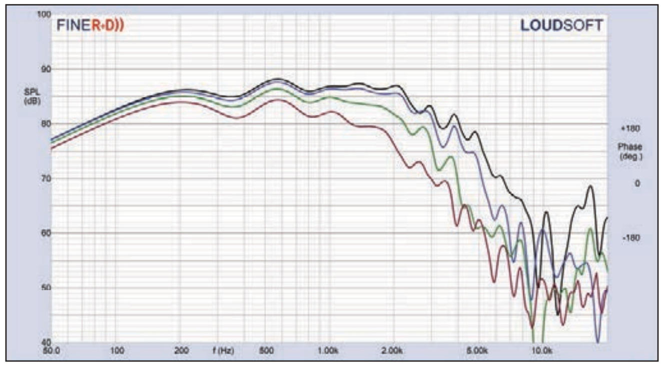

Figure 30: TB Speaker W8-2314 woofer on- and off-axis frequency response (black = 0°, blue = 15°, green = 30°, purple = 45°)

of these SPL measurements also included a 1/12 octave smoothing.

Figure 28 gives the W8-2314 woofer's on-axis response. **Figure 29** shows the tweeter's on-axis response. The woofer has a smooth rising response out to 2 kHz with no serious anomalies where it begins a typical second-order low-pass roll-off. For the tweeter, the response extends from 800 Hz to 36 kHz.

Figure 30 depicts the woofer's on- and off-axis frequency response at 0°, 15°, 30°, and 45° degrees. The -3 dB at 30° with respect to the on-axis curve occurs at 1.8 kHz making 2 kHz to 2.5 kHz a reasonable crossover range.

Figure 31 gives the normalized version of Figure 30. **Figure 32** depicts the Clio 180° polar pot (in 10°

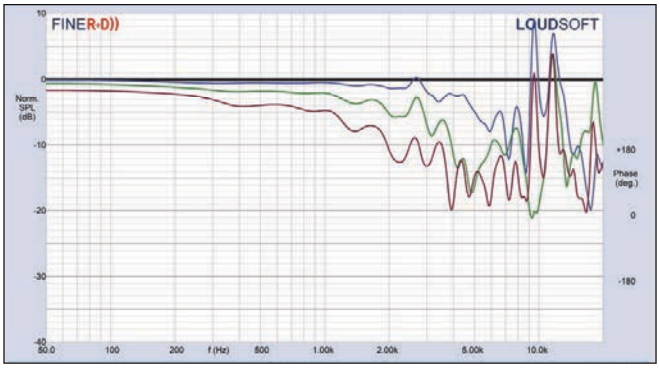

Figure 31: TB Speaker W8-2314 woofer normalized on- and off-axis frequency response (black = 0°, blue = 15°, green = 30°, purple = 45°)

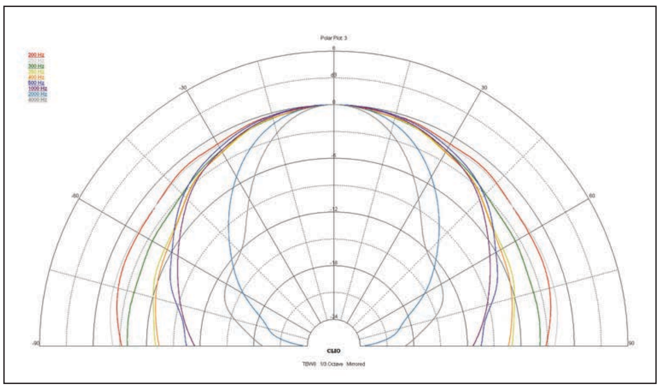

Figure 32: TB Speaker W8-2314 woofer horizontal CLIO polar plot

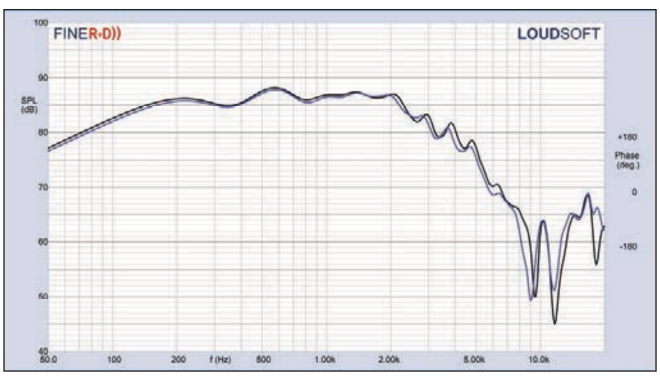

Figure 33: TB Speaker W8-2314 woofer two-sample SPL comparison

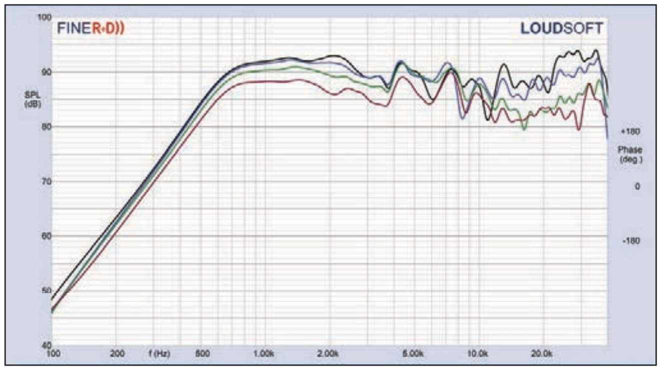

Figure 34: TB Speaker W8-2314 tweeter on- and off-axis frequency response (black = 0°, blue = 15°, green = 30°, purple = 45°)

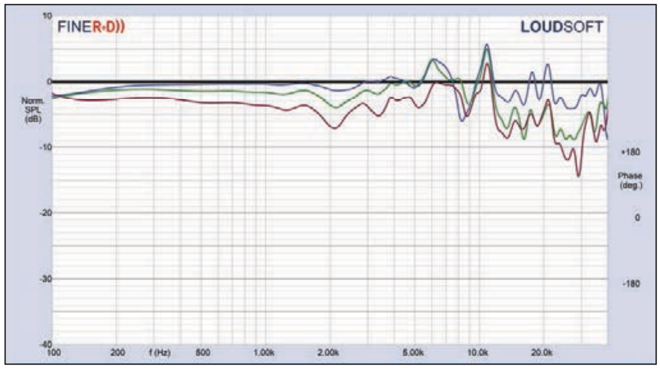

Figure 35: TB Speaker W8-2314 tweeter normalized on- and off-axis frequency response (black = 0°, blue = 15°, green = 30°, purple = 45°)

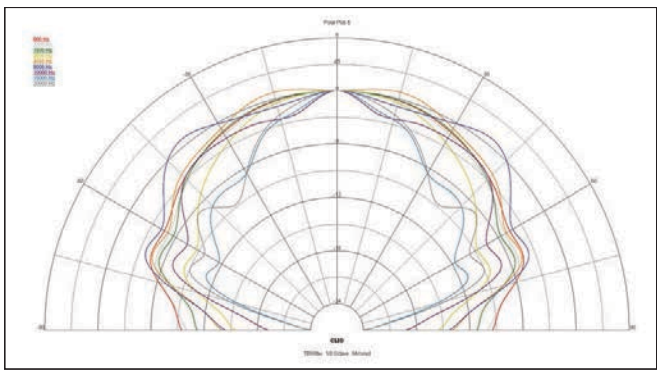

Figure 36: TB Speaker W8-2314 tweeter horizontal CLIO polar plot

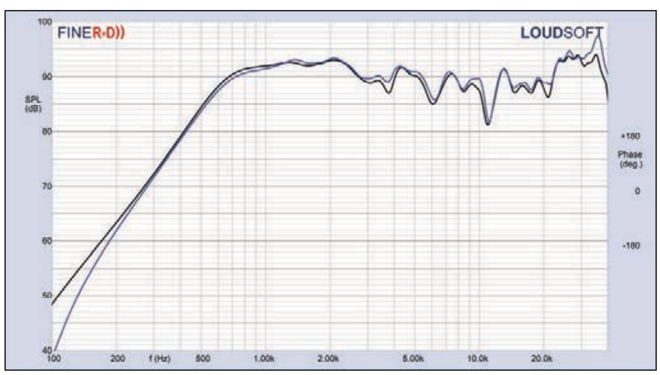

Figure 37: TB Speaker W8-2314 tweeter two-sample SPL comparison

increments). And last, **Figure 33** gives the two-sample SPL comparisons for the W8-2314 woofer samples, both samples are closely matched, within 0.5 dB to 1 dB.

For the tweeter, **Figure 34** shows the on- and off-axis horizontal frequency response out to 45°. **Figure 35** shows the normalized version. **Figure 36** shows the Clio

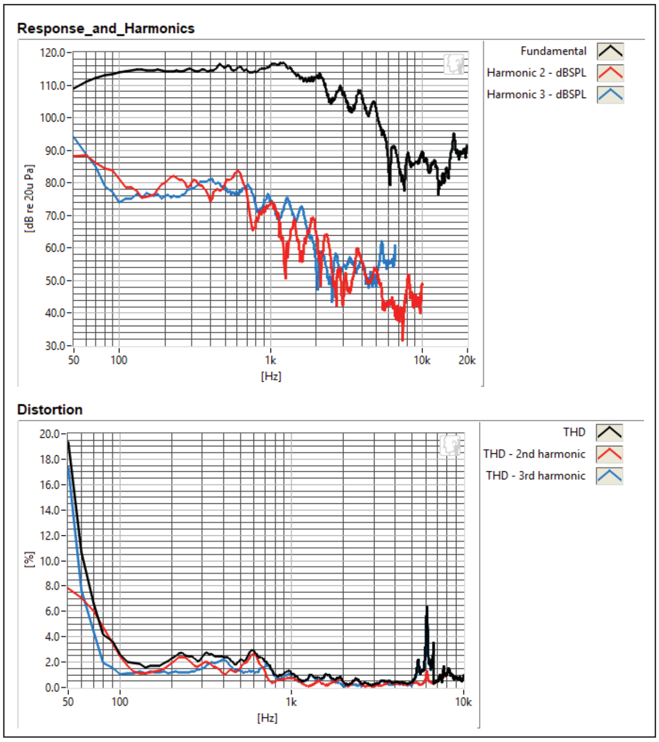

Figure 38: TB Speaker W8-2314 woofer SoundCheck distortion plot

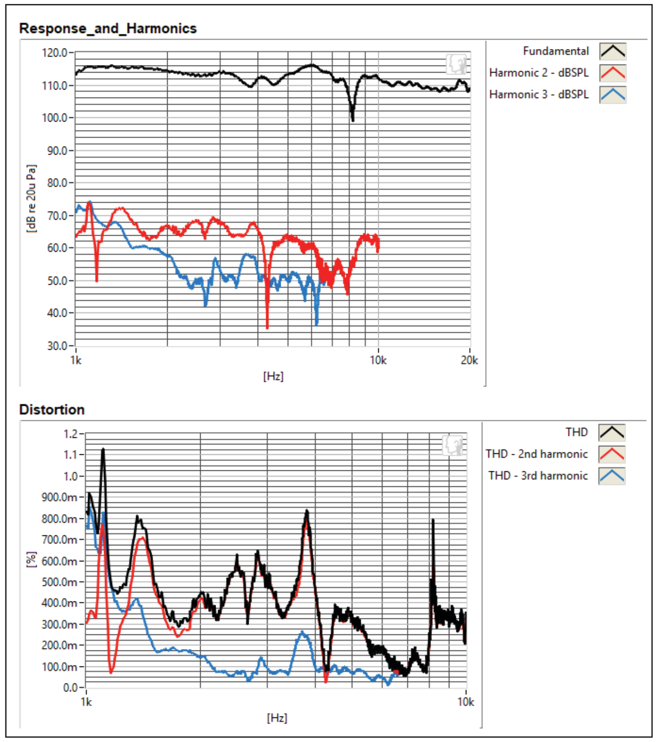

Figure 39: TB Speaker W8-2314 tweeter SoundCheck distortion plot

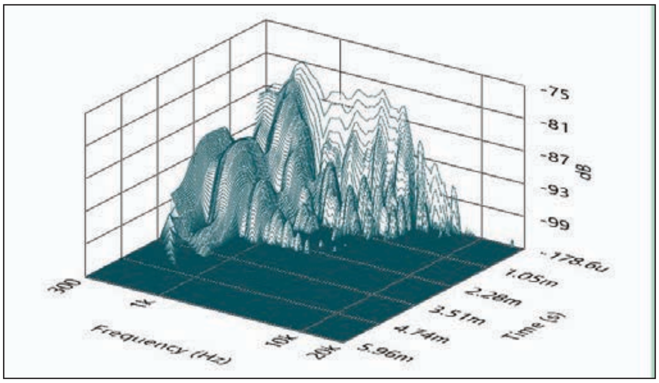

Figure 40: TB Speaker W8-2314 woofer SoundCheck CSD waterfall plot

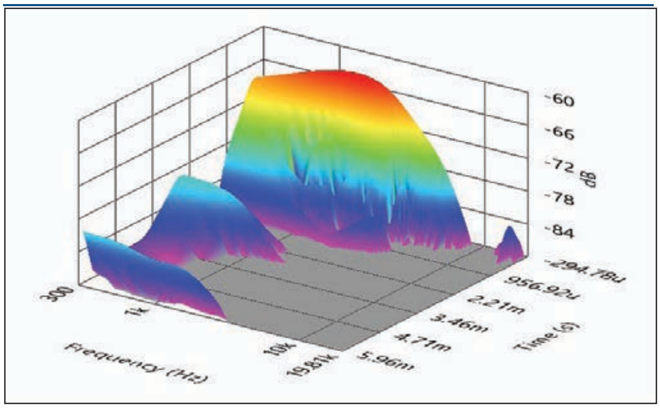

Figure 41: TB Speaker W8-2314 woofer SoundCheck Wigner-Ville plot

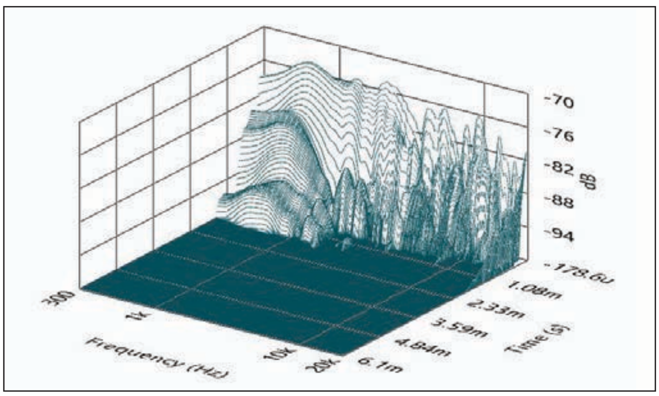

Figure 42: TB Speaker W8-2314 tweeter SoundCheck CSD waterfall plot

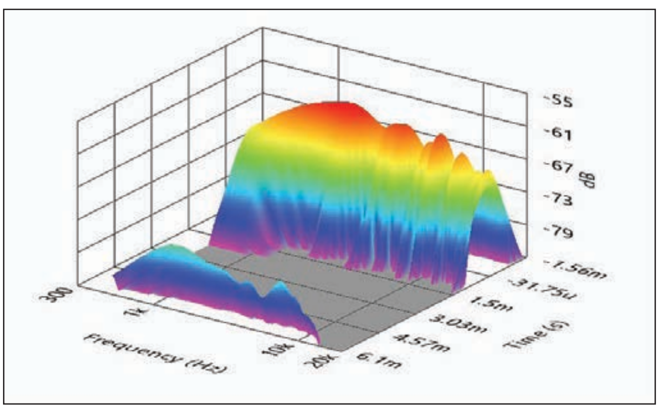

Figure 43: TB Speaker W8-2314 tweeter SoundCheck STFT plot

180° polar plot (processed in 10° increments). **Figure 37** depicts the two-sample SPL comparison for the TB Speaker tweeter, which is also within 0.5 dB to 2 dB throughout the entire frequency range.

The final group of tests was performed using the Listen, Inc. AudioConnect analyzer and SC-1 microphone along with the SoundCheck 17 software to measure distortion and generate time-frequency plots. Setting up for the distortion measurement consisted of mounting the driver rigidly in free-air, and using a pink noise stimulus to determine the voltage level to raise SPL to 94 dB at 1 m. (SoundCheck has a software generator and SPL meter as two of its utilities.)

Next, I measured the distortion with the Listen microphone placed 10 cm from the midrange's dust cap and the tweeter dome. **Figure 38** shows the distortion curves for the woofer (7.86 V). **Figure 39** shows the distortion curves for the tweeter dome (3.85 V).

With the distortion tests completed, I next set up SoundCheck 17 to produce a 2.83 V/1 m impulse response for both the W8-2314 woofer and the tweeter and imported the data into Listen's SoundMap Time/Frequency software. **Figure 40** shows the resulting CSD waterfall plot for the W8-2314 woofer. **Figure 41** shows the resulting CSD waterfall plot for the tweeter dome. **Figure 42** shows the Wigner-Ville logarithmic surface map for the woofer. **Figure 43** shows the Short Time Fourier Transform (STFT) graph for the 25 mm aluminum/magnesium tweeter.

I would definitely applaud TB Speaker for its innovation in the development of this coaxial transducer. For more information, visit www.tb-speaker.com. ***VC***

Submit Samples to Test Bench

Test Bench is an open forum for OEM driver manufacturers in the loudspeaker industry. OEMs are invited to submit samples to *Voice Coil* for inclusion in the monthly Test Bench column. Driver samples can include transducers for home audio, car audio, pro sound, multimedia, or musical instrument applications. While many of the drivers featured in *Voice Coil* come from OEMs that have a stable catalog of products, this is not a necessary criterion. Any woofer, midrange, or tweeter an OEM manufacturer feels is representative of its work, is welcome to send samples. However, contact *Voice Coil* Editor Vance Dickason, prior to submission to discuss which drivers are being submitted. Send samples in pairs and addressed to:

Vance Dickason Consulting
333 S. State St., #152
Lake Oswego, OR 97034
(503-557-0427)
vdconsult@comcast.net

All samples must include any published data on the product, patent information, or any special information necessary to explain the functioning of the transducer. This should include details regarding the various materials used to construct the transducer (e.g., cone material, voice coil former material, and voice coil wire type). For woofers and midrange drivers, please include the voice coil height, gap height, RMS power handling, and physically measured Mmd (complete cone assembly including the cone, surround, spider, and voice coil with 50% of the spider, surround and lead wires removed).